
Space Weather Technical Forecast

Issued on Tuesday, 26 March 2024 at 01:26 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Further Minor/Moderate radio blackouts (R1/R2) likely. A slowly reducing chance of Minor to Moderate geomagnetic storms (G1-G2) over the next few days as CME influence eases. A slight chance of further Strong geomagnetic storm (G3) interval at first. Electron Fluence likely rising above the Active threshold into the period.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity recorded at GOES16 and 18 was moderate with the leading portion of AR3615 producing an M4.4 flare at 25/0644UTC. Eight active regions currently on the visible disc. AR3615 remains by far the largest and most complex group (Fkc/Beta-Gamma-Delta), although this region continues to display slight simplification of its magnetic structure. Changes in other groups were minor. The small, bipolar region to the southwest of AR3615 was numbered AR3623.

No significant Earth-directed Coronal Mass Ejections (CMEs) observed on available coronagraph imagery over the last 24hr, although investigation of any glancing risk from a CME associated with a C7.8 flare associated with AR3622 at 25/1415UTC is ongoing.

Solar Wind / Geomagnetic Activity: The solar wind at L1 measured by ACE and DSCOVR were initially at strong-very strong speeds (750-850 km/s) following the arrival of the CME associated with the X1.1 flare on the 23rd March that arrived at L1 at 24/1410UTC. From around 25/1500UTC winds began erratically declining to reach current strong speeds of around 600km/s. The solar wind density largely around or above average to start fell steadily to below average levels. The IMF was initially strong following the CME arrival, but steadily eased, becoming weak at around 8nT from 25/1000UTC where it remains. Bz initially strongly positive within the likely magnetic cloud but also declined in magnitude, becoming generally weakly positive from 25/1000UTC. The phi angle largely negative (towards the Sun) initially but turned positive (Away from the sun) around 25/1500UTC.

The net result of the above solar wind measures was initially Active to G1 (Kp4-5) geomagnetic conditions, which slowly declined to Quite (Kp2).

Energetic Particles / Solar Radiation: Solar radiation was at S1 levels initially but on a slow and steady decline, falling below the S1 threshold from 25/1410UTC. High energy electron flux (greater than 2MeV) observed at GOES16 was at Normal Background levels. The observed 24-hour fluence was below the Active threshold, with a value at 26/0001UTC of 1.06e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Generally moderate solar activity is expected, with further M-class flares expected from primarily the highly active AR3615 through the forecast period, with a slight chance of isolated X-class flares.

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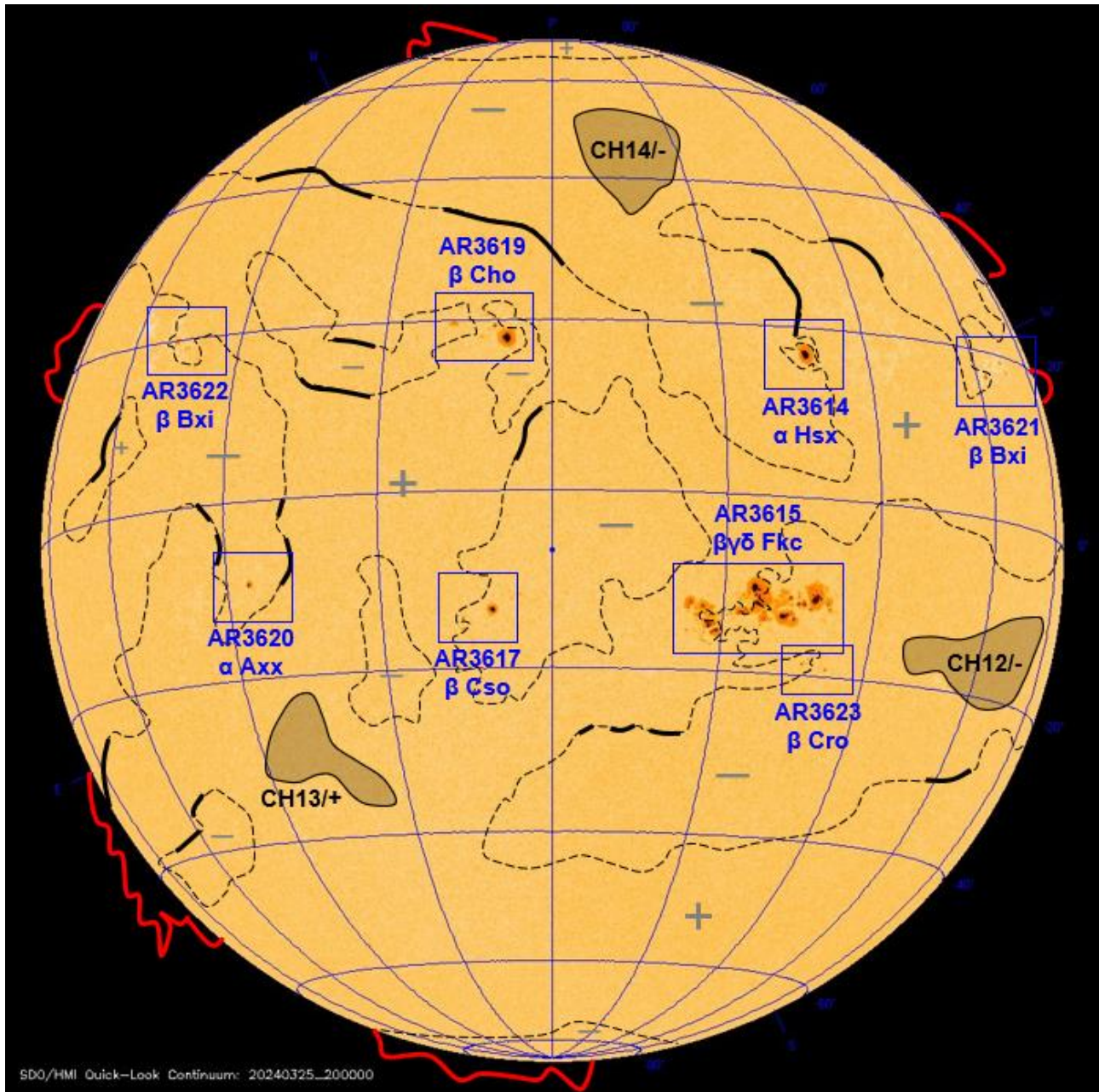
Solar Wind / Geomagnetic Activity: A CME associated with the X1.1 flare from a broad region north of AR3614 on the 23rd March, produced a complex halo CME which arrived at L1 at 24/1410UTC. There are no other Earth-directed CME's currently in the forecast. Solar winds at current strong levels expected to decline erratically through day 1 (26 Mar) and into day 2 (27 Mar) as the impacts from the CME continue to wane. With any residual enhancement associated with CH12/- expected to be clearing. Winds are expected to continue to fall towards background values into day 3 and 4 (28-29 Mar) in the absence of forecast enhancements.

Generally Unsettled to Active conditions expected initially but with a steadily reducing chance of further G1-G2, minor to moderate storm conditions and a slight chance of a G3 strong geomagnetic storm. By days 3 and 4 (28-29 Mar) conditions expected to become generally Quiet (Kp1-2) in the absence of any further CME enhancements.

Energetic Particles / Solar Radiation: High energy proton flux, as observed by GOES18 is continuing to decline from recent enhancement. A continued slow decline is expected in the absence of further significant flare activity, however continued CME influence lowers confidence in the near term, with a chance of further enhancement, this risk reducing somewhat into the period

High energy electron flux (greater than 2MeV) remains at background levels at first, given the ongoing geomagnetic conditions associated with the HSS and recent CME impact. Activity is expected to increase given the solar winds likely ease in coming days with a sharp increase likely to high levels. The associated 24-hour fluence is below Active threshold initially, but with an increasing likelihood of reaching Active fluence through the guidance period, becoming expected by days 3 and 4 (28-29 Mar).

Figure 1. Solar Analysis Valid 25/2000UTC.



Key: Filament —, Prominence —, Magnetic Field Line - - -, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α - β - $\beta\gamma$ - $\beta\gamma\delta$ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

A CME associated with the X1.1 flare from a broad region north of AR3614 on the 23rd March, produced a complex halo CME which arrived at L1 at 24/1410UTC. There are no other Earth-directed CME's currently in the forecast.

Solar winds at current strong levels expected to decline erratically through day 1 (26 Mar) and into day 2 (27 Mar) as the impacts from the CME continue to wane. With any residual enhancement associated with CH12/- expected to be clearing by that stage winds are expected to continue to fall towards background values into day 3 and 4 (28-29 Mar) in the absence of forecast enhancements.

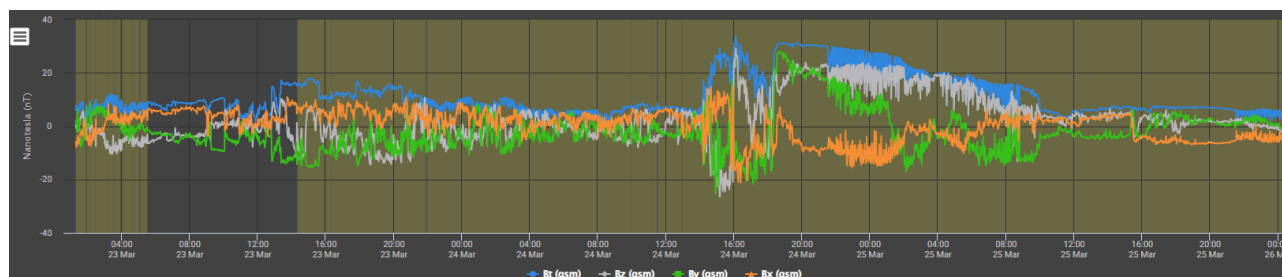
Generally Unsettled to Active conditions expected initially but with a steadily reducing chance of further G1-G2, minor to moderate storm conditions and a very slight chance of a G3 strong geomagnetic storm. By day 3 and 4 (28-29 Mar) conditions expected to become generally Quiet (Kp1-2) in the absence of any further CME enhancements.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	Yes	50	30	10	1
Strong	G3	No	10	5	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil

Figure 2: 72hr L1 Magnetometer trance, showing clear CME arrival and continued decline.



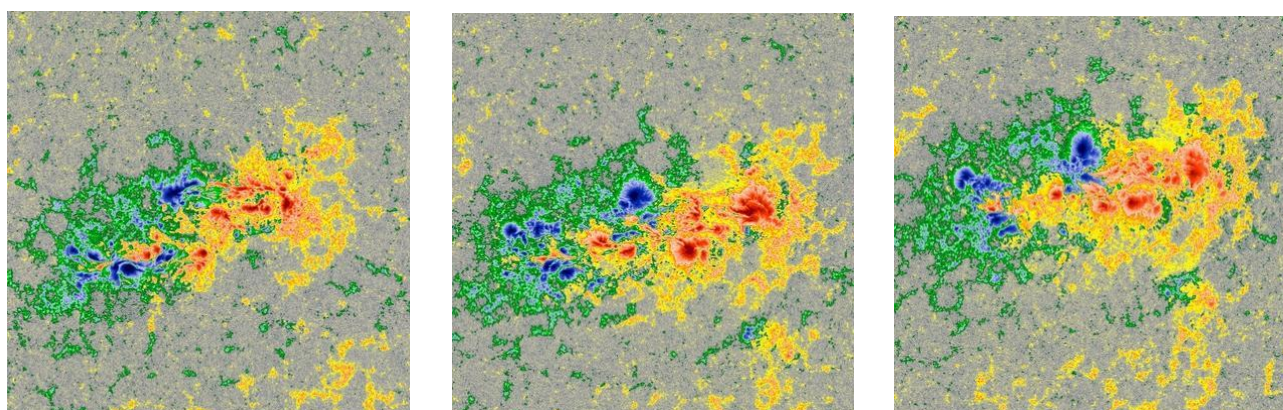
Radio Blackouts - X-Ray Flares:

The current Earth-facing disc remains dominated by AR3615, by far the largest and most complex group. This region has been highly active in recent days and produced a M4.4 flare at 25/0644UTC. Activity appears to have waned somewhat in recent hours however, with slight simplification of its magnetic structure and continued areal consolidation. Despite this, significant mixing of its constituent magnetic polarities remains evident and it continues to displays a Mt Wilson Beta-Gamma-Delta configuration. The recent X1.1 flare on the 23rd was primarily associated with AR3614, which remains generally stable and much more magnetically simple, though it remains within a large plage region. All other regions remain significantly simpler, although recent flare and CME activity from AR3622 in the northeast indicate they should not be completely discounted.

AR3615 (and AR3614) will remain on the visible disk throughout this guidance period, and although AR3615's activity appears somewhat reduced for now, the size, complexity and total flux continue to represent a high risk of activity, with further M-class flares likely and slight chance of isolated X-class flares. Some suggestions from far-side sounding data that returning regions may rotate onto the southeast disk into the latter half of the period. For now flare risk is maintained throughout.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	70	70	70	70
Very Active	R3 to R5 X Class	No	20	20	20	20

Figure 3: SDO/HMI Magnetogram imagery of AR3615 on the 23rd, 24th and 25th (left to right), showing some apparent magnetic simplification, particularly across the trailing portion.



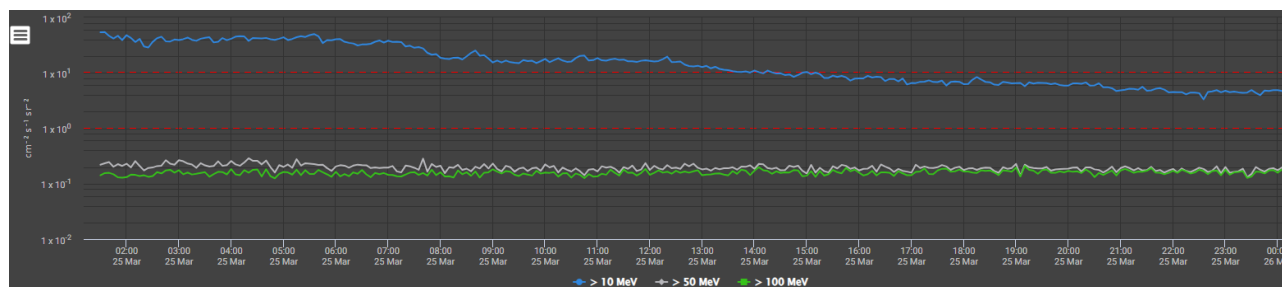
Solar Radiation Storms - (High Energy Protons):

High energy proton flux, as observed by GOES18 is continuing to decline from recent enhancement. A continued slow decline is expected in the absence of further significant flare activity, however continued CME influence lowers confidence in the near term. Into the second half of the period the risk of enhancement increasingly becomes dominated by AR3615 as it makes continued progress westward and any CME influence wanes. Overall a reducing chance of further enhancement expected.

Radiation Storms	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	Yes	50	30	20	20
Very Active	$\geq \text{S3}$ *	No	1	1	1	1

* $\text{S3} \geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and / or $\geq 50 \text{ MeV} \geq 10 \text{ pfu}$. (pfu = $\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)

Figure 4: Latest 24hr GOES18 Proton Flux trace



High Energy Electrons Event ($\geq 2\text{MeV}$):

GOES16 high energy electron flux is at background levels currently given the geomagnetic response associated with the likely ongoing connection to the HSS of CH12/- and recent strong CME arrival. As geomagnetic activity and solar wind speeds likely ease over the next few days the electron flux at GEO is expected to quickly rise to Moderate or High levels.

The associated 24-hour fluence is currently below the Active threshold. Fluence is expected to rise sharply in the coming days with active fluence becoming increasingly likely. MOSWOC REFM output shows very high levels of forecast fluence day 1 (26 Mar), this viewed as unlikely given likely ongoing fast solar winds. However an increase in Fluence above the active threshold into days 3 and 4 (28-29 Mar) is accepted as good guidance.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	No	10	50	80	80
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	5	5	15	10